List of Abstracts

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ELG Carbon Fibre Ltd.

Carbon Fibre Recycling and Quality Management (P1)

ELG Carbon Fibre’s mission is to industrialise high-volume recycling processes for the low-cost and sustainable use of carbon fibre in the automotive and aerospace sectors. This presentation will look at the products, process routes and quality management procedures in place which ensure ELG products are ready to use in the market. Beside a brief presentation of the company and ELG products, this presentation will answer the question why carbon fibre recycling is important and which are the main reasons to do carbon fibre recycling. Furthermore an overview of the process chain of carbon fibre recycling from different feedstocks will be given.
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RISE Bioeconomy (Innventia), Research Institute of Sweden

Lignin-based carbon fibers: fiber spinning and conversion (P2)
The high cost of carbon fibers is the main limitation in expanding the application of
this high strength and lightweight fibers. Polyacrylonitrile (PAN) is the dominant pre-
cursor for making carbon fibers and about 51% of the total manufacturing cost of ca-bon fiber is precursor. Lignin is the second most abundant natural polymer on the
planet and its characteristics such as low cost, high carbon content, and aromatic
structure makes it an attractive choice as a carbon fiber precursor. Lignins, from dif-
f erent botanical sources or isolation methods, were selected and in-
vestigated for manufacturing carbon fibers. Chemical compositions of lignin samples
were determined, and their thermal properties were analyzed using thermogravimet-
ric analysis and differential scanning calorimetry. Fiber spinning was performed at
different conditions to produce green fibers. Lignin fibers were subsequently thermo-
 stabilized and carbonized at different conditions. The morphology of carbon fibers
was examined using a scanning electron microscopy and tensile properties of the
carbon fibers were measured according to the ASTM standard. Effects of different
parameters on spinnability, conversion, and properties of carbon fibers will be pre-
sented. In addition, challenges related to manufacturing lignin-based carbon fibers
will be discussed.
MCC - MineralCarbonComposites, a new way to utilize carbon fibers in a most efficient way (P3)

MCC-MineralCarbonComposite is a new material paradigm in which the combination of carbon fibers and mineral materials with the help of CFS (CarbonFiberStone). CFS is a connection of hard rock and carbon, whereby the fibre prestresses the stone. CFS material is thus able to handle the connection of carbon fibres and concrete without affecting the different coefficients of expansion. The long-term plan is to produce carbon fibres from biomass to achieve CO₂ negativity. In order to achieve the necessary climatic relevance, the carbon fibre still lacks scalable applications in construction. Initial successes can be expected with the combination of carbon and concrete. CFS can also be used directly to replace the CO₂-intensive concrete, which in this case can also be used to replace the CO₂-intensive concrete. The building permit is missing, because the resins lack the temperature stability. For this reason, a high-temperature-resistant adhesive as a substitute for resins will be developed, which is supposed to improve fire protection. The first idea on this topic will be presented in this presentation.
Composite materials offer the possibility for tailored properties that open a large design space for multi-parameter optimization of designs. For applications in machine tools the most important properties are high specific and absolute stiffness, thermal stability as well as high material damping. Because of its central function, a vertical z-slide of a milling machine was selected as a demonstrator component within the framework of the cooperative project “Intelligent light weight structures for hybrid machine tools (HYBRIDi)”. Boundary conditions and requirements of this substitution design lead to a hybrid multi-material construction with highly tailored composite material components. This presentation addresses challenges and solution approaches in the design and optimization of tailored composites for the application in hybrid machine tool components.
Tim Röding, Andreas De Palmenaer, Thomas Gries

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Future Prospects and Challenges of Polyethylene Based Carbon Fibres (P5)

The global demand for carbon fibres for the year 2016 was approximately 70 kt and is anticipated to exceed 100 kt by 2020. Currently, the aviation and aerospace sector represents the most significant segment in terms of demand. Then again, automotive and wind applications are becoming increasingly important. Although the trend for growth of carbon fibre market is expected to remain strong with a growth in the range of +8 to +14 % per annum, the manufacturing costs are still one of the limiting factor for carbon fibre use in mass market applications. Since potential cost savings of optimizing the conventional polyacrylonitrile-(PAN-)based process chain are too low, new processing concepts have to be developed. Approximately 50 % of the PAN-based carbon fibres’ production costs are caused by the precursor production process. Therefore, alternative precursors for carbon fibre production are currently being researched. Among the new precursors, polyethylene (PE) is the most promising alternative.

The presentation shares the future developments in research on PE-based carbon fibres. Major challenges lie, on the one hand, in developing industrial scale production equipment, and on the other, in optimizing and harmonizing the individual production steps along the process chain. In addition to the technological aspects, developments at fibre level are also presented.
Ulrich Mörschel, Stefan Fliescher

Textechno Herbert Stein GmbH & Co. KG

ROVINGTEST: A new device to determine the processing and spreading properties of rovings (P6)

Most fibers which end up as a reinforcement in a composite part have been produced in form of a roving or yarn. On the way into the composite part rovings are processed in various ways. The processing properties of rovings therefore can have an impact on both, processing costs and the quality of the final composite part. More and more processes include spreading as an essential part.

Textechno, German world-market leader in the field of testing equipment for man-made fibers and yarns, has thus developed ROVINGTEST, a flexible and modular testing system for the processing and spreading properties of rovings. Processing properties which can be determined include:

- coefficients of friction (roving to metal/ceramics and roving to roving),
- fiber damage by contact with surfaces,
- number of broken filaments before and after contact with surfaces,
- fiber fluff generated by contact with surfaces,
- deposit of fiber fluff and sizing on surfaces,
- homogeneity of filament orientation (carbon fibers, only).

Spreading properties include the width of the roving before and after spreading (including their statistics over the measured yarn length), spreading ratio and the amount and size of gaps. Suggestions for determination of further parameters are most welcome.

The ROVINGTEST complements Textechno’s FIMATEST system which determines the fiber/matrix adhesion by means of reproducible embedding and single-fiber pullout test, since good processing properties seem to be in a certain contradiction with good fiber/matrix adhesion.
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Multi scale modeling approach of a virtual process chain based on a carbon fiber micro model (P9)

The demand for lightweight materials is rising due to resource scarcity, environmental awareness and legal provisions. Fiber reinforced composites (FRCs) are among the most desirable lightweight materials, which combine strong mechanical properties with low density. One big challenge for FRCs is the high costs in comparison to conventional materials, like steel or aluminum. The high costs arise from three aspects. These aspects are high material costs, many and cost intensive production steps and often the demand of manually processing. The costs of FRCs need to be reduced to enable a higher market share.

The cost reduction of the production can be achieved through modeling the effects of the production processes on the fiber materials. With this, sources of errors can be identified and improved. Furthermore, a more precise material design and possible lower security factors can be achieved due to a production history of the FRC.

The new approach to achieve the goals is a micro model with entanglement and sizing. Thus, the structure of a filament tow can be modeled accurate. In the first step, the model will be validated on basis of the fiber spreading process. Later, homogenization and discretization methods will utilized to deduce material properties for the meso scale and loads from the meso scale to the micro scale.
Magdalena Kimm, Thomas Gries

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Resource-efficient application of composites in the construction sector (P8)

Fiber reinforced composites (FRCs) are being used increasingly in the construction industry, because of their outstanding properties regarding multifunctionality, design, weight, and cost. But the novelty and structural complexity of FRCs is also a challenge for the material cycles, since few and expensive recycling technologies exist for these products. So, their great advantage of resource efficiency mostly ends with their service life. Regarding the huge waste stream which is produced by the construction sector every year and counts up to 60 % of all waste, the end of life behavior should be considered from the very beginning.

The start of the value chain, the design, production and processing of FRC, offers a variety of approaches exist to put resource efficiency into practice. Three approaches for the construction sector are presented in this work:

1. Design for recycling of carbon textile reinforced concrete
2. Closed-loop production process for textile reinforced concrete
3. Use of secondary materials: recycled carbon fibers for fiber reinforced concrete

In approach 1 it could be shown that separation of carbon fiber and concrete fraction of carbon textile reinforced concrete significantly depend on the fiber’s coating material, the separation method, the textile structure and other factors. By choosing the adequate composition, a recycling is enabled and facilitated.

In approach 2 the current production waste of the industry partner Fydro B.V., Ede, Netherlands, be halved during the next two years. On a business management level, the organizational processes will be optimized in terms of time, quality and costs. At the technological level, the sustainability of the production process will be increased, e. g. by using internal waste as secondary materials.